Update to Hazard Assessment of Selenium Contamination at Benton Lake National Wildlife Refuge

Service Unit: Benton Lake NWR
Species or group: Wetland contamination
BNL Biological Report: 2-07
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Introduction

In 2006, the selenium contamination hazard was re-assessed after a 10 year hiatus in monitoring after the selenium problem was first characterized in the mid 1990s. In 1994, researchers did multiple samples of the sediment in Unit I to characterize the overall level of contamination in this unit (Zhang and Moore 1997). This unit is of particular interest because it is the location where Lake Creek, and most of the selenium, enter the refuge wetlands. In 2006, some of these same locations in Unit I were resampled, however, the sampling technique did not select for the upper 2cm of sediment, as had been done in 1994. This is important because this upper layer of sediment is where the highest concentrations of selenium can be found. All of the sediment sampling locations in 1994 in Unit I were revisited in 2008 and a revised technique was used to sample only the upper 2cm. This update includes the results of this re-sampling.

In addition, water was sampled for dissolved selenium in Lake Creek at the point where it enters the refuge to further refine the relationship between specific conductance (measured by the continuous water quality meter at this location) and selenium concentration. The results of these samples are also included in this update.

Methods

Using the hardcopy map from Zhang and Moore (1997), the previous sediment sampling locations were digitized and loaded into a GPS for sampling in the field. We used a 3" polycarbonate tube and fitted plunger to sample in each location. The tube, with the plunger inserted, was pushed by hand into the sediment in each location. The clay that is a few centimeters down creates a plug, which makes it possible to lift the tube out of the water with the sample intact (Fig 1). The sample was then extruded into a modified PVC tube (see Fig. 2) with 1cm markings. The top 2cm were cut with a plastic knife and transferred to the chemically clean sample jars. All equipment was chemically cleaned with a detergent-acid-distilled water wash prior to sampling and rinsed with wetland water between samples.

Water samples from Lake Creek were collected and tested in 2007 and 2008 the same manner as described in the original report.

Figure 1. Sample in tube

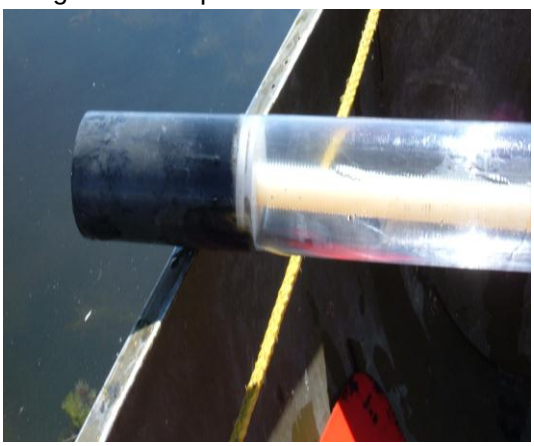
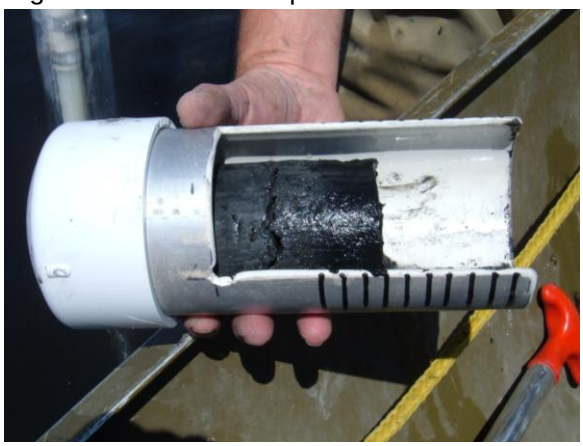


Figure 2. Extruded sample



Results

The results of the 2008 sediment sampling in Unit I are summarized in Figure 3. There was no clear trend from the revised sampling. Some 2008 samples were higher in selenium concentration and some were lower than both the 2006 and 1994 samples. The mean selenium concentration in 2008 was 2.65 µg/g (95%CI=2.15-3.14 µg/g). In 1994, the mean selenium concentration was 2.06 µg/g (95%CI=1.31-2.82 µg/g). A t-test (Welch two sample) of the 2008 and 1994 samples found no significant difference (df=21, p=0.17).

The specific conductance and selenium concentration from the additional water samples are shown in Table 1. These values fall within the 95% confidence interval of the original equation. Although including these values in the regression equation improves the R2 value from 0.9 to 0.91 and revises the equation to Se = (SpCond-628.8)/51.249 (p=0.0000).

Discussion

The variability in selenium concentrations in the sediments of Unit I between years is probably due in part to the fact that the sampling locations were similar, but not exactly the same between years. Also, different analysis labs and different sampling techniques introduce additional variation.

Most of the selenium concentrations in the upper sediment in 2008 were around 2-3 ug/g (mean=2.65±0.23). However, the two values ≥4ug/g near the inlet of Lake Creek may be of concern. This is the high hazard threshold for toxicity to aquatic systems and occurs where we would expect the highest levels of deposition of selenium from water into the sediment. Selenium concentrations in bird eggs from Unit I in 2006 were generally of low levels (6-10ug/g) suggesting that birds are feeding over a wide enough area, with presumably lower levels of contamination, such that selenium is not reaching a level of reproductive harm.

Figure 3. Selenium concentrations (ug/g) in sediment in Unit I 1994, 2006 and 2008.

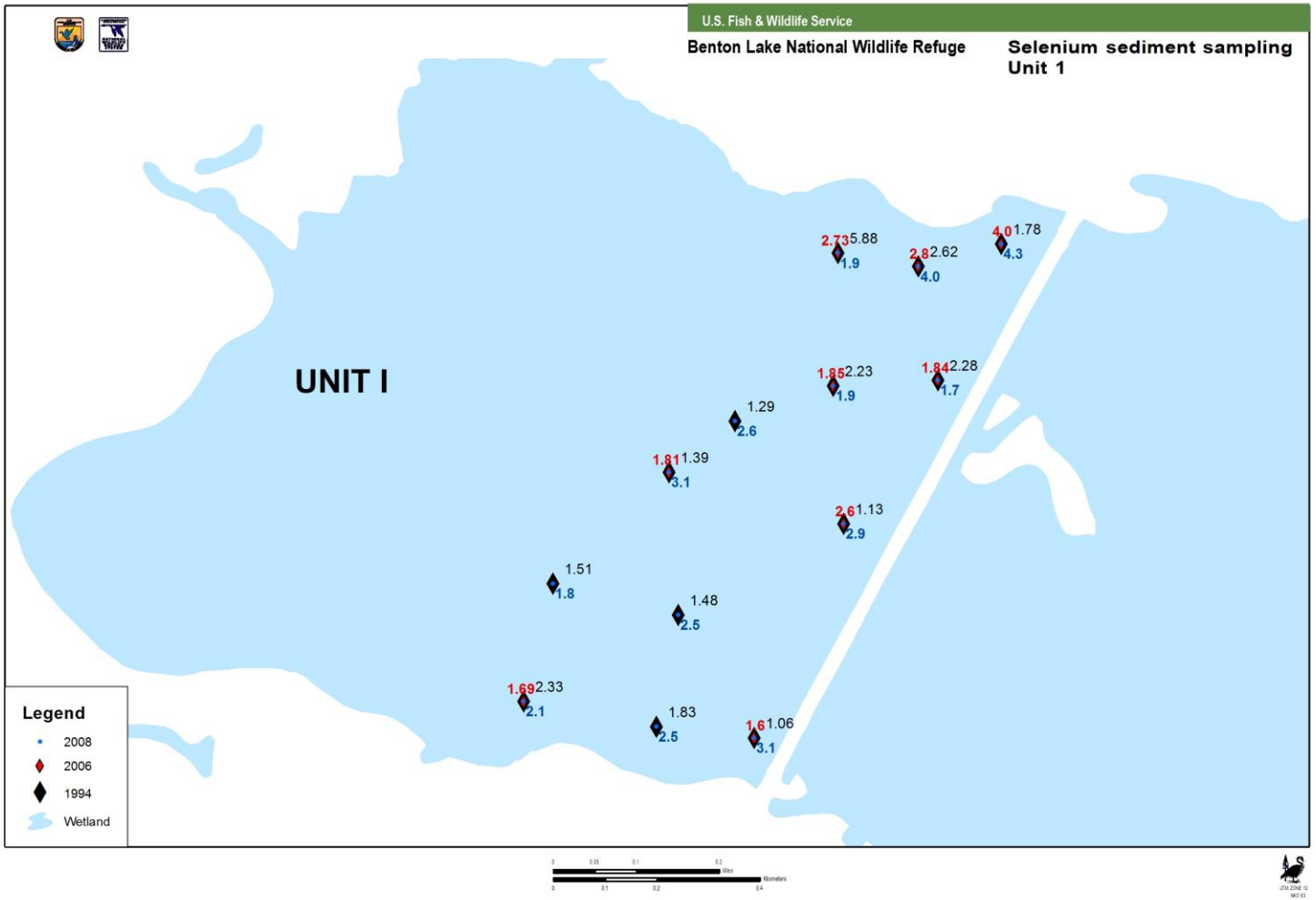


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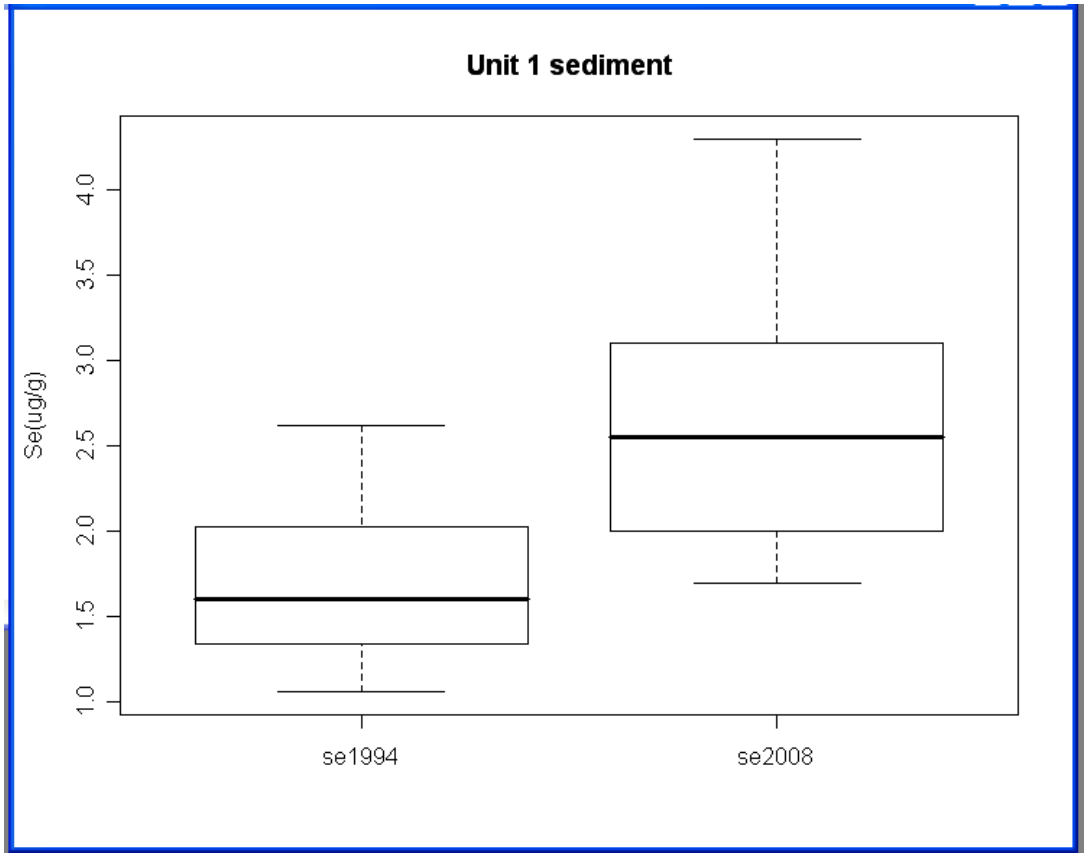
Table 1. Selenium and Specific Conductance values from Lake Creek where it enters Benton Lake NWR, 2006-2008.

Lake Creek Water		
Sample	Specific Conductance (25°C)	Se (ug/L)
BLLCW160606	8420	155
BLLCW260906	698	2.29
BLLCW361306	1030	11.43
BLLCW561606	2229	37.18
BLLCW662006	2543	42.32
BLLCW1162606	2126	66.61
BLLCW1263006	5120	61.83
BLLCW1380306	1257	12.95
BLLCW1480806	668	2.08
BLLCW1581006	675	1.83
BLLCW1681406	665	1.79
BLLCW141408*	4406	55
BLLCW281808	745	2.5
BLLCW1051507	5300	82.1
BLLCW2080207	1580	12.5
BLLCW3081007	742	1.72

*estimated from hydrolab, YSI meter malfunctioned



REFERENCES

Zhang, Y. and J. Moore. 1997. Final report on biogeochemical cycling of selenium in Benton Lake, Montana. University of Montana, Missoula, MT, 228pp.